CLAIMS

What is claimed is:

1. A method of designing a direct expansion geothermal heat exchange system comprising:

providing system heating and cooling load design sizing by means of calculating heating loads utilizing the 99% Design Dry Bulb temperature as listed under column 5 of the Table 1 Climatic Conditions for the United States, in the ASHRAE Fundamentals Handbook, calculating cooling loads utilizing the design temperature that is the greater of the 1% Design Dry Bulb temperature, as listed under column 6, or the Medium of Annual Extremes Maximum Temperature, as listed under column 10, of the Table 1 Climatic Conditions for the United States, in the ASHRAE Fundamentals Handbook, and calculating the system's design load to the maximum of the greater of the heating and cooling design loads without exceeding a 200% greater heating to cooling design load;

providing a refrigerant with heating/cooling operational working pressures between 80 psi and 405 psi;

providing an R-410A refrigerant;

providing refrigerant tubing design lengths at a minimum of 100 feet per ton of maximum system tonnage design when the heat exchange vapor line is within

95%, or greater, rock, where rock excludes pumice, obsidian, and all other porous rock that is not permanently water saturated;

providing refrigerant tubing design lengths at a minimum of 110 feet per ton of maximum system tonnage design when the heat exchange vapor line is within 80%, or greater, rock, or is within permanently water saturated sand, where rock excludes pumice, obsidian, and all other porous rock that is not permanently water saturated;

providing refrigerant tubing design lengths at a minimum of 125 feet per ton of maximum system tonnage design when the heat exchange vapor line is within soil; excluding soil containing 20%, or more, of clay and/or sand that is not permanently moist;

providing refrigerant tubing design lengths at a minimum of 175 feet per ton of maximum system tonnage design when the heat exchange vapor line is within soil containing 20%, or more, of clay and/or sand that is not permanently moist;

providing refrigerant grade tubing sizing used to connect the interior equipment, such as the compressor unit and the air handler, with the exterior sub-surface heat exchanger line sizing, as follows,

for a 12,000 BTU through 30,000 BTU compressor size, use a 3/8 inch liquid line and a 3/4 inch vapor line,

for a 36,000 BTU through 48,000 BTU compressor size, use a 1/2 inch liquid line and a 7/8 inch vapor line,

for a 54,000 BTU through 60,000 BTU compressor size, use a 1/2 inch liquid line and a 1 inch vapor line;

providing refrigerant tubing sizing, when utilizing a borehole method of sub-surface heat transfer tubing installation, as follows,

for a 12,000 BTU through a 30,000 BTU compressor size, use one 3/8 inch Liquid Line and one 3/4 inch Vapor Line in one borehole for all standard designs up to 125 feet per ton, with the one exception of when any one borehole exceeds 300 feet in depth, and in such event, two equally sized boreholes must be used as necessary so as not to exceed the 300 foot depth limitation per borehole, with each respective borehole utilizing one 3/8 inch Liquid Line and one 3/4 inch Vapor Line, and

for a 36,000 BTU through 60,000 BTU compressor size, use two boreholes, with each respective, and equally sized, borehole containing a respective 3/8 inch Liquid Line and a respective 3/4 inch Vapor Line, with the one exception of when any two boreholes, respectively exceed 300 feet in depth each, and in such event, three equally sized boreholes must be utilized as necessary so as not to exceed the 300 foot depth limitation per borehole, with each respective borehole utilizing one 3/8 inch Liquid Line and one 3/4 inch Vapor Line;

providing a rope attached to the lower segment of the refrigerant transport tubing as a means to lower/extract the refrigerant transport tubing into/out of one of a borehole and a fluid filled containment pipe, together with one of a rigid pipe, a small wheel, and a wire rope thimble, placed at the surface edge of the one of the borehole and pipe to serve as a rope guide;

providing one of a solid encasement around the lower segment of refrigerant transport tubing to be lowered into one of a borehole and a pipe, and a bar affixed to the lower segment of the refrigerant transport tubing to be lowered into one of a borehole and a pipe for at least one purpose of protection, strength, and rope attachment;

providing an above-ground winch, positioned at the ground surface in working proximity to a borehole, which winch is used to control the rope, secured to the lower segment of the copper refrigerant transport tubing/lines, used to lower/raise the entire sub-surface heat transfer copper refrigerant transport tubing assembly into/out of one of a borehole and a pipe;

providing a compressor with a tonnage design capacity that is designed at 90%, plus or minus 5% of 100%, of the direct expansion system's maximum load tonnage design capacity, in the greater of the heating mode and the cooling mode;

providing an optional two speed compressor where one high speed is operating at full 100% BTU compressor design capacity output, and where a second

low speed is operating at 67% of full compressor design capacity output, plus or minus 2% of 100%;

providing an optional two-speed compressor with the high speed designed for use in one of the the heating mode and the cooling mode, and with the low speed designed for use in the cooling mode;

providing an interior heat exchanger tonnage capacity designed at 140% (plus or minus 10% of 100%) of the maximum compressor tonnage design capacity;

providing an interior heat exchanger, optionally comprised of an air handler, where the air handler provides 400 CFM, plus or minus 25 CFM, per ton of the maximum system tonnage design capacity for a single speed compressor operating in a reverse cycle mode,;

providing an interior heat exchanger, optionally comprised of an air handler, where the air handler provides 350 CFM to 375 CFM per ton of the maximum system tonnage design capacity for an optional two speed compressor operating in the heating mode, and where the air handler provides 425 CFM to 450 CFM per ton of the maximum system tonnage design capacity for an optional two speed compressor operating in the cooling mode;

providing an accumulator with a tonnage design capacity that is designed at 90%, plus or minus 5% of 100%, of the direct expansion system's maximum load tonnage design capacity, in the greater of the heating mode and the cooling mode;

providing a single piston metering device in the heating mode, with the following pin restrictor (Aeroquip type) sizing, based on central hole bore size in inches, utilized, plus or minus a maximum of two (2) one thousandths of an inch (0.001) central hole bore size, within the following depth ranges,

Maximum Heating Tonnage Design...........Pin Restrictor Central Bore Hole Size In Inches

*0 to 50feet (depth of borehole below compressor unit)

1.5 ....0.041

2...0.049

2.5..0.055

3...0.059

3.5..0.063

4...0.065

4.5..0.068

5...0.071

*51 to 175 feet (depth of borehole below compressor unit)

1.5 ....0.039

2...0.047

2.5..0.052

3...0.056

3.5..0.060

4..0.062

4.5..0.065

5..0.067

*176 to 300 feet (depth of borehole below compressor unit)

1.5 ....0.037

2..0.044

2.5..0.050

3..0.053

3.5..0.057

4..0.059

4.5..0.061

5..0.064;

providing, in the cooling mode, a self-adjusting thermostatic expansion valve which is located proximate to the interior air handler and is sized at 140%, plus or minus 10% of 100%, of the maximum compressor tonnage design capacity in the cooling mode;

providing an optional single piston metering device, situated proximate to the interior air handler in the cooling mode, with the following pin restrictor (Aeroquip type) sizing, based on central hole bore size in inches, utilized, plus or minus a

maximum of two (2) one thousandths of an inch (0.001) central hole bore size, within the following depth ranges,

Maximum Cooling Tonnage Design - Pin Restrictor Bore Size In Inches

*0 to 50 feet (height of interior air handler above the compressor unit)

1.5 ....0.058

2..0.070

2.5...0.077

3..0.085

3.5...0.093

4..0.099

4.5...0.100

5..0.112;

providing a charging of the refrigerant system in the cooling mode until the peak operational efficiency is reached and the superheat is within the 10 to 25 degree F range, the head pressure is within the 305 to 405 PSI range, the liquid head pressure is within the 195 to 275 PSI range, which is similar to the head pressure range in the heating mode, the suction pressure is within the 80 to 160 PSI range, and the suction/vapor temperature is within the 37 degree to 55 degree F. temperature range;

providing a receiver sized to hold at least 40% of the maximum direct expansion system operational refrigerant charge;

providing, when elements potentially corrosive to copper are encountered in the sub-surface environment, the sub-surface un-insulated vapor refrigerant transport copper tubing, as well as the sub-surface insulated liquid refrigerant transport copper tubing and its surrounding insulation, as well as all sub-surface copper couplings, are completely surrounded by a watertight protective covering prior to insertion into the borehole;

providing, when elements potentially corrosive to copper are encountered in the sub-surface environment, the sub-surface un-insulated vapor refrigerant transport copper tubing, as well as the sub-surface insulated liquid refrigerant transport copper tubing and its surrounding insulation, as well as all sub-surface copper couplings, are all completely surrounded and encased by Grout Mix 111 after their insertion into a well/borehole and/or after their insertion into any other potentially copper corrosive subsurface environment;

providing an optional water-tight pipe installed within a well/borehole to hold and encase the subsurface geothermal heat exchange refrigerant transport tubing, which pipe is additionally filled with a heat conductive fill material, and which pipe is surrounded by an exterior heat conductive fill material, which exterior heat

conductive fill material fills the space between the exterior of the pipe's wall and the interior wall of the well/borehole;

providing an optional watertight pipe comprised of at least one of steel, galvanized steel, and polyethylene;

providing one of a fluid and a gel as a heat conductive fill material to fill the remaining interior of the optional water-tight pipe installed within a well/borehole, which pipe primarily contains the subsurface geothermal heat exchange refrigerant transport tubing;

providing an optional fluid, comprised of at least 50% propylene glycol, as a heat conductive fill material to fill the remaining interior of the optional water-tight pipe installed within a well/borehole, which pipe primarily contains the subsurface geothermal heat exchange refrigerant transport tubing;

providing full insulation for all of the exterior connecting refrigerant transport lines;

providing a protective watertight encasement for all of the exterior and insulated connecting refrigerant transport lines;

providing no low-pressure cut-off timing switch/device for the system's compressor other than the compressor's own internal cut-off switch;

providing an optional low refrigerant pressure cut-off timing switch/device designed to deactivate the compressor only after a minimum continuous 15 minute period of below minimum requisite system refrigerant operational pressures;

providing returning the oil from an oil separator directly to one of the compressor's suction line prior to the accumulator and to the accumulator itself;

providing for the addition of extra compressor lubricating oil, with the amount of extra oil to be added being determined by multiplying the system charge in pounds of refrigerant by 2.2%, and multiplying this number by 16 fl. oz. (1 pound), and by then subtracting from this result 8% of the fluid ounces of oil shown on the compressor nameplate, and by then adding the amount of oil shown, if any, to one of the system's receiver and the system's liquid line in the heating mode; and

providing a polyolester oil for use in conjunction with a direct expansion system utilizing an R-410A refrigerant.

2. A method of designing a direct expansion geothermal heat exchange system comprising providing system design heating and cooling load sizing by means of calculating heating loads utilizing the 99% Design Dry Bulb temperature as listed under column 5 of the Table 1 Climatic Conditions for the United States, in the ASHRAE Fundamentals Handbook, calculating cooling loads utilizing the design temperature that is the greater of the 1% Design Dry Bulb temperature, as listed under column 6, or the Medium of Annual Extremes Maximum Temperature, as

listed under column 10, of the Table 1 Climatic Conditions for the United States, in the ASHRAE Fundamentals Handbook, and calculating the system's design load to the maximum of the greater of the heating and cooling design loads without exceeding a 200% greater heating to cooling design load.

3. A method of designing a direct expansion geothermal heat exchange system comprising providing a refrigerant with heating/cooling operational working pressures between 80 psi and 405 psi.

4. The method of claim 3, further comprising providing an R-410A refrigerant.

5. The method of claim 4, further comprising providing a polyolester oil.

6. A method of designing a direct expansion geothermal heat exchange system comprising providing refrigerant tubing design lengths at a minimum of 100 feet per ton of maximum system tonnage design when the heat exchange vapor line is within 95%, or greater, rock, where rock excludes pumice, obsidian, and all other porous rock that is not permanently water saturated;

providing refrigerant tubing design lengths at a minimum of 110 feet per ton of maximum system tonnage design when the heat exchange vapor line is within 80%, or greater, rock, or is within permanently water saturated sand, where rock excludes pumice, obsidian, and all other porous rock that is not permanently water saturated;

providing refrigerant tubing design lengths at a minimum of 125 feet per ton of maximum system tonnage design when the heat exchange vapor line is within soil; excluding soil containing 20%, or more, of clay and/or sand that is not permanently moist; and

providing refrigerant tubing design lengths at a minimum of 175 feet per ton of maximum system tonnage design when the heat exchange vapor line is within soil containing 20%, or more, of clay and/or sand that is not permanently moist.

7. A method of designing a direct expansion geothermal heat exchange system comprising providing refrigerant grade tubing sizing used to connect the interior equipment, such as the compressor unit and the air handler, with the exterior sub-surface heat exchanger line sizing, as follows,

for a 12,000 BTU through 30,000 BTU compressor size, use a 3/8 inch liquid line and a 3/4 inch vapor line,

for a 36,000 BTU through 48,000 BTU compressor size, use a 1/2 inch liquid line and a 7/8 inch vapor line, and

for a 54,000 BTU through 60,000 BTU compressor size, use a 1/2 inch liquid line and a 1 inch vapor line.

8. A method of designing a direct expansion geothermal heat exchange system comprising providing refrigerant tubing sizing, when utilizing a borehole method of sub-surface heat transfer tubing installation, as follows,

for a 12,000 BTU through a 30,000 BTU compressor size, use one 3/8 inch Liquid Line and one 3/4 inch Vapor Line in one borehole for all standard designs up to 125 feet per ton, with the one exception of when any one borehole exceeds 300 feet in depth, and in such event, two equally sized boreholes must be used as necessary so as not to exceed the 300 foot depth limitation per borehole, with each respective borehole utilizing one 3/8 inch Liquid Line and one 3/4 inch Vapor Line, and

for a 36,000 BTU through 60,000 BTU compressor size, use two boreholes, with each respective, and equally sized, borehole containing a respective 3/8 inch Liquid Line and a respective 3/4 inch Vapor Line, with the one exception of when any two boreholes, respectively exceed 300 feet in depth each, and in such event, three equally sized boreholes must be utilized as necessary so as not to exceed the 300 foot depth limitation per borehole, with each respective borehole utilizing one 3/8 inch Liquid Line and one 3/4 inch Vapor Line.

9. A method of designing a direct expansion geothermal heat exchange system comprising providing a rope attached to the lower segment of the refrigerant transport tubing as a means to lower/extract the refrigerant transport tubing into/out of one of a borehole and a fluid filled containment pipe, together with a smooth surface rope guide placed at the surface edge of the one of the borehole and pipe.

10. The method of claim 9, further comprising providing one of a solid encasement around the lower segment of refrigerant transport tubing to be lowered into one of a borehole and a pipe, and a bar affixed to the lower segment of the refrigerant transport tubing to be lowered into one of a borehole and a pipe for at least one purpose of protection, strength, and rope attachment.

11. The method of claim 9, further comprising providing an above-ground winch, positioned at the ground surface in working proximity to a borehole, which winch is used to control the rope, secured to the lower segment of the copper refrigerant transport tubing/lines, used to lower/raise the entire sub-surface heat transfer copper refrigerant transport tubing assembly into/out of one of a borehole and a pipe.

12. A method of designing a direct expansion geothermal heat exchange system comprising providing a compressor with a tonnage design capacity that is designed at 90%, plus or minus 5% of 100%, of the direct expansion system's maximum load tonnage design capacity, in the greater of the heating mode and the cooling mode.

13. The method of claim 12, further comprising providing an optional two speed compressor where one high speed is operating at full 100% BTU compressor design capacity output, and where a second low speed is operating at 67% of full compressor design capacity output, plus or minus 2% of 100%.

14. The method of claim 13, further comprising providing an optional two-speed compressor with the high speed designed for use in one of the the heating mode and the cooling mode, and with the low speed designed for use in the cooling mode.

15. A method of designing a direct expansion geothermal heat exchange system comprising providing a single piston metering device in the heating mode, with the following pin restrictor (Aeroquip type) sizing, based on central hole bore size in inches, utilized, plus or minus a maximum of two (2) one thousandths of an inch (0.001) central hole bore size, within the following depth ranges,

Maximum Heating Tonnage Design...........Pin Restrictor Central Bore Hole Size In Inches

*0 to 50feet (depth of borehole below compressor unit)

1.5 ....0.041

2...0.049

2.5...0.055

3...0.059

3.5...0.063

4...0.065

4.5...0.068

5...0.071

*51 to 175 feet (depth of borehole below compressor unit)

1.5	0.039
2	0.047
2.5	0.052
3	0.056
3.5	0.060
4	0.062
4.5	0.065
5	0.067

*176 to 300 feet (depth of borehole below compressor unit)

1.5	0.037
2	0.044
2.5	0.050
3	0.053
3.5	0.057
4	0.059
4.5	0.061
5	0.064;

16. A method of designing a direct expansion geothermal heat exchange system comprising providing, in the cooling mode, a self-adjusting thermostatic expansion

valve which is located proximate to the interior air handler and is sized at 140%, plus or minus 10% of 100%, of the maximum compressor tonnage design capacity in the cooling mode.

17. A method of designing a direct expansion geothermal heat exchange system comprising providing an optional single piston metering device, situated proximate to the interior air handler in the cooling mode, with the following pin restrictor (Aeroquip type) sizing, based on central hole bore size in inches, utilized, plus or minus a maximum of two (2) one thousandths of an inch (0.001) central hole bore size, within the following depth ranges,

Maximum Cooling Tonnage Design - Pin Restrictor Bore Size In Inches

*0 to 50 feet (height of interior air handler above the compressor unit)

1.5 ....0.058

2..0.070

2.5...0.077

3..0.085

3.5...0.093

4..0.099

4.5...0.100

5..0.112.

18. A method of designing a direct expansion geothermal heat exchange system comprising providing a charging of the refrigerant system in the cooling mode until the peak operational efficiency is reached and the superheat is within the 10 to 25 degree F range, the head pressure is within the 305 to 405 PSI range, the liquid head pressure is within the 195 to 275 PSI range, which is similar to the head pressure range in the heating mode, the suction pressure is within the 80 to 160 PSI range, and the suction/vapor temperature is within the 37 degree to 55 degree F. temperature range.

19. A method of designing a direct expansion geothermal heat exchange system comprising providing a receiver sized to hold at least 40% of the maximum direct expansion system operational refrigerant charge.

20. A method of designing a direct expansion geothermal heat exchange system comprising providing, when elements potentially corrosive to copper are encountered in the sub-surface environment, the sub-surface un-insulated vapor refrigerant transport copper tubing, as well as the sub-surface insulated liquid refrigerant transport copper tubing and its surrounding insulation, as well as all sub-surface copper couplings, are completely surrounded by a watertight protective covering prior to insertion into the borehole.

21. A method of designing a direct expansion geothermal heat exchange system comprising providing, when elements potentially corrosive to copper are

encountered in the sub-surface environment, the sub-surface un-insulated vapor refrigerant transport copper tubing, as well as the sub-surface insulated liquid refrigerant transport copper tubing and its surrounding insulation, as well as all sub-surface copper couplings, are all completely surrounded and encased by Grout Mix 111 after their insertion into a well/borehole and/or after their insertion into any other potentially copper corrosive subsurface environment.

22. A method of designing a direct expansion geothermal heat exchange system comprising providing an optional water-tight pipe installed within a well/borehole to hold and encase the subsurface geothermal heat exchange refrigerant transport tubing, which pipe is additionally filled with a heat conductive fill material, and which pipe is surrounded by an exterior heat conductive fill material, which exterior heat conductive fill material fills the space between the exterior of the pipe's wall and the interior wall of the well/borehole.

23. The method of claim 22, further comprising providing an optional watertight pipe comprised of at least one of steel, galvanized steel, and polyethylene.

24. The method of claim 22, further comprising providing one of a fluid and a gel as a heat conductive fill material to fill the remaining interior of the optional water-tight pipe installed within a well/borehole, which pipe primarily contains the subsurface geothermal heat exchange refrigerant transport tubing.

25. The method of claim 24, further comprising providing providing an optional fluid, comprised of at least 50% propylene glycol, as a heat conductive fill material to fill the remaining interior of the optional water-tight pipe installed within a well/borehole, which pipe primarily contains the subsurface geothermal heat exchange refrigerant transport tubing.

26. A method of designing a direct expansion geothermal heat exchange system comprising providing full insulation for all of the exterior connecting refrigerant transport lines.

27. The method of claim 26, further comprising providing a protective watertight encasement for all of the exterior and insulated connecting refrigerant transport lines.

28. A method of designing a direct expansion geothermal heat exchange system comprising providing no low-pressure cut-off timing switch/device for the system's compressor other than the compressor's own internal cut-off switch.

29. A method of designing a direct expansion geothermal heat exchange system comprising providing an optional low refrigerant pressure cut-off timing switch/device designed to deactivate the compressor only after a minimum continuous 15 minute period of below minimum requisite system refrigerant operational pressures.

30. A method of designing a direct expansion geothermal heat exchange system comprising providing returning the oil from an oil separator directly to one of the compressor's suction line prior to the accumulator and to the accumulator itself.

31. A method of designing a direct expansion geothermal heat exchange system comprising providing for the addition of extra compressor lubricating oil, with the amount of extra oil to be added being determined by multiplying the system charge in pounds of refrigerant by 2.2%, and multiplying this number by 16 fl. oz. (1 pound), and by then subtracting from this result 8% of the fluid ounces of oil shown on the compressor nameplate, and by then adding the amount of oil shown, if any, to one of the system's receiver and the system's liquid line in the heating mode.

32. A direct expansion geothermal heat exchange system comprising:

providing system heating and cooling load design sizing by means of calculating heating loads utilizing the 99% Design Dry Bulb temperature as listed under column 5 of the Table 1 Climatic Conditions for the United States, in the ASHRAE Fundamentals Handbook, calculating cooling loads utilizing the design temperature that is the greater of the 1% Design Dry Bulb temperature, as listed under column 6, or the Medium of Annual Extremes Maximum Temperature, as listed under column 10, of the Table 1 Climatic Conditions for the United States, in the ASHRAE Fundamentals Handbook, and calculating the system's design load to

the maximum of the greater of the heating and cooling design loads without exceeding a 200% greater heating to cooling design load;

providing a refrigerant with heating/cooling operational working pressures between 80 psi and 405 psi;

providing an R-410A refrigerant;

providing refrigerant tubing design lengths at a minimum of 100 feet per ton of maximum system tonnage design when the heat exchange vapor line is within 95%, or greater, rock, where rock excludes pumice, obsidian, and all other porous rock that is not permanently water saturated;

providing refrigerant tubing design lengths at a minimum of 110 feet per ton of maximum system tonnage design when the heat exchange vapor line is within 80%, or greater, rock, or is within permanently water saturated sand, where rock excludes pumice, obsidian, and all other porous rock that is not permanently water saturated;

providing refrigerant tubing design lengths at a minimum of 125 feet per ton of maximum system tonnage design when the heat exchange vapor line is within soil; excluding soil containing 20%, or more, of clay and/or sand that is not permanently moist;

providing refrigerant tubing design lengths at a minimum of 175 feet per ton of maximum system tonnage design when the heat exchange vapor line is within soil containing 20%, or more, of clay and/or sand that is not permanently moist;

providing refrigerant grade tubing sizing used to connect the interior equipment, such as the compressor unit and the air handler, with the exterior sub-surface heat exchanger line sizing, as follows,

for a 12,000 BTU through 30,000 BTU compressor size, use a 3/8 inch liquid line and a 3/4 inch vapor line,

for a 36,000 BTU through 48,000 BTU compressor size, use a 1/2 inch liquid line and a 7/8 inch vapor line,

for a 54,000 BTU through 60,000 BTU compressor size, use a 1/2 inch liquid line and a 1 inch vapor line;

providing refrigerant tubing sizing, when utilizing a borehole method of sub-surface heat transfer tubing installation, as follows,

for a 12,000 BTU through a 30,000 BTU compressor size, use one 3/8 inch Liquid Line and one 3/4 inch Vapor Line in one borehole for all standard designs up to 125 feet per ton, with the one exception of when any one borehole exceeds 300 feet in depth, and in such event, two equally sized boreholes must be used as necessary so as not to exceed the 300 foot depth limitation per borehole, with each respective borehole utilizing one 3/8 inch Liquid Line and one 3/4 inch Vapor Line, and

for a 36,000 BTU through 60,000 BTU compressor size, use two boreholes, with each respective, and equally sized, borehole containing a respective 3/8 inch Liquid Line and a respective 3/4 inch Vapor Line, with the one exception of when any two boreholes, respectively exceed 300 feet in depth each, and in such event, three equally sized boreholes must be utilized as necessary so as not to exceed the 300 foot depth limitation per borehole, with each respective borehole utilizing one 3/8 inch Liquid Line and one 3/4 inch Vapor Line;

providing a rope attached to the lower segment of the refrigerant transport tubing as a means to lower/extract the refrigerant transport tubing into/out of one of a borehole and a fluid filled containment pipe, together with one of a rigid pipe, a small wheel, and a wire rope thimble, placed at the surface edge of the one of the borehole and pipe to serve as a rope guide;

providing one of a solid encasement around the lower segment of refrigerant transport tubing to be lowered into one of a borehole and a pipe, and a bar affixed to the lower segment of the refrigerant transport tubing to be lowered into one of a borehole and a pipe for at least one purpose of protection, strength, and rope attachment;

providing an above-ground winch, positioned at the ground surface in working proximity to a borehole, which winch is used to control the rope, secured to the lower segment of the copper refrigerant transport tubing/lines, used to

lower/raise the entire sub-surface heat transfer copper refrigerant transport tubing assembly into/out of one of a borehole and a pipe;

providing a compressor with a tonnage design capacity that is designed at 90%, plus or minus 5% of 100%, of the direct expansion system's maximum load tonnage design capacity, in the greater of the heating mode and the cooling mode;

providing an optional two speed compressor where one high speed is operating at full 100% BTU compressor design capacity output, and where a second low speed is operating at 67% of full compressor design capacity output, plus or minus 2% of 100%;

providing an optional two-speed compressor with the high speed designed for use in one of the the heating mode and the cooling mode, and with the low speed designed for use in the cooling mode;

providing an interior heat exchanger tonnage capacity designed at 140% (plus or minus 10% of 100%) of the maximum compressor tonnage design capacity;

providing an interior heat exchanger, optionally comprised of an air handler, where the air handler provides 400 CFM, plus or minus 25 CFM, per ton of the maximum system tonnage design capacity for a single speed compressor operating in a reverse cycle mode,;

providing an interior heat exchanger, optionally comprised of an air handler, where the air handler provides 350 CFM to 375 CFM per ton of the maximum

system tonnage design capacity for an optional two speed compressor operating in the heating mode, and where the air handler provides 425 CFM to 450 CFM per ton of the maximum system tonnage design capacity for an optional two speed compressor operating in the cooling mode;

providing an accumulator with a tonnage design capacity that is designed at 90%, plus or minus 5% of 100%, of the direct expansion system's maximum load tonnage design capacity, in the greater of the heating mode and the cooling mode;

providing a single piston metering device in the heating mode, with the following pin restrictor (Aeroquip type) sizing, based on central hole bore size in inches, utilized, plus or minus a maximum of two (2) one thousandths of an inch (0.001) central hole bore size, within the following depth ranges,

Maximum Heating Tonnage Design............Pin Restrictor Central Bore Hole Size In Inches

*0 to 50feet (depth of borehole below compressor unit)

1.5 ....0.041

2...0.049

2.5..0.055

3...0.059

3.5..0.063

4...0.065

4.5..0.068

5...0.071

*51 to 175 feet (depth of borehole below compressor unit)

1.5 ....0.039

2...0.047

2.5..0.052

3...0.056

3.5..0.060

4...0.062

4.5..0.065

5...0.067

*176 to 300 feet (depth of borehole below compressor unit)

1.5 ....0.037

2...0.044

2.5..0.050

3...0.053

3.5..0.057

4...0.059

4.5..0.061

5...0.064;

providing, in the cooling mode, a self-adjusting thermostatic expansion valve which is located proximate to the interior air handler and is sized at 140%, plus or minus 10% of 100%, of the maximum compressor tonnage design capacity in the cooling mode;

providing an optional single piston metering device, situated proximate to the interior air handler in the cooling mode, with the following pin restrictor (Aeroquip type) sizing, based on central hole bore size in inches, utilized, plus or minus a maximum of two (2) one thousandths of an inch (0.001) central hole bore size, within the following depth ranges,

Maximum Cooling Tonnage Design - Pin Restrictor Bore Size In Inches

*0 to 50 feet (height of interior air handler above the compressor unit)

1.5 ....0.058

2...0.070

2.5..0.077

3...0.085

3.5..0.093

4...0.099

4.5..0.100

5...0.112;

providing a charging of the refrigerant system in the cooling mode until the peak operational efficiency is reached and the superheat is within the 10 to 25 degree F range, the head pressure is within the 305 to 405 PSI range, the liquid head pressure is within the 195 to 275 PSI range, which is similar to the head pressure range in the heating mode, the suction pressure is within the 80 to 160 PSI range, and the suction/vapor temperature is within the 37 degree to 55 degree F. temperature range;

providing a receiver sized to hold at least 40% of the maximum direct expansion system operational refrigerant charge;

providing, when elements potentially corrosive to copper are encountered in the sub-surface environment, the sub-surface un-insulated vapor refrigerant transport copper tubing, as well as the sub-surface insulated liquid refrigerant transport copper tubing and its surrounding insulation, as well as all sub-surface copper couplings, are completely surrounded by a watertight protective covering prior to insertion into the borehole;

providing, when elements potentially corrosive to copper are encountered in the sub-surface environment, the sub-surface un-insulated vapor refrigerant transport copper tubing, as well as the sub-surface insulated liquid refrigerant transport copper tubing and its surrounding insulation, as well as all sub-surface copper couplings, are all completely surrounded and encased by Grout Mix 111 after

their insertion into a well/borehole and/or after their insertion into any other potentially copper corrosive subsurface environment;

providing an optional water-tight pipe installed within a well/borehole to hold and encase the subsurface geothermal heat exchange refrigerant transport tubing, which pipe is additionally filled with a heat conductive fill material, and which pipe is surrounded by an exterior heat conductive fill material, which exterior heat conductive fill material fills the space between the exterior of the pipe's wall and the interior wall of the well/borehole;

providing an optional watertight pipe comprised of at least one of steel, galvanized steel, and polyethylene;

providing one of a fluid and a gel as a heat conductive fill material to fill the remaining interior of the optional water-tight pipe installed within a well/borehole, which pipe primarily contains the subsurface geothermal heat exchange refrigerant transport tubing;

providing an optional fluid, comprised of at least 50% propylene glycol, as a heat conductive fill material to fill the remaining interior of the optional water-tight pipe installed within a well/borehole, which pipe primarily contains the subsurface geothermal heat exchange refrigerant transport tubing;

providing full insulation for all of the exterior connecting refrigerant transport lines;

providing a protective watertight encasement for all of the exterior and insulated connecting refrigerant transport lines;

providing no low-pressure cut-off timing switch/device for the system's compressor other than the compressor's own internal cut-off switch;

providing an optional low refrigerant pressure cut-off timing switch/device designed to deactivate the compressor only after a minimum continuous 15 minute period of below minimum requisite system refrigerant operational pressures;

providing returning the oil from an oil separator directly to one of the compressor's suction line prior to the accumulator and to the accumulator itself;

providing for the addition of extra compressor lubricating oil, with the amount of extra oil to be added being determined by multiplying the system charge in pounds of refrigerant by 2.2%, and multiplying this number by 16 fl. oz. (1 pound), and by then subtracting from this result 8% of the fluid ounces of oil shown on the compressor nameplate, and by then adding the amount of oil shown, if any, to one of the system's receiver and the system's liquid line in the heating mode; and

providing a polyolester oil for use in conjunction with a direct expansion system utilizing an R-410A refrigerant.

33. A direct expansion geothermal heat exchange load design system comprising providing system design heating and cooling load sizing by means of calculating heating loads utilizing the 99% Design Dry Bulb temperature as listed

under column 5 of the Table 1 Climatic Conditions for the United States, in the ASHRAE Fundamentals Handbook, calculating cooling loads utilizing the design temperature that is the greater of the 1% Design Dry Bulb temperature, as listed under column 6, or the Medium of Annual Extremes Maximum Temperature, as listed under column 10, of the Table 1 Climatic Conditions for the United States, in the ASHRAE Fundamentals Handbook, and calculating the system's design load to the maximum of the greater of the heating and cooling design loads without exceeding a 200% greater heating to cooling design load.

34. A direct expansion geothermal heat exchange system comprising providing a refrigerant with heating/cooling operational working pressures between 80 psi and 405 psi.

35. The system of claim 34, further comprising providing an R-410A refrigerant.

36. The system of claim 35, further comprising providing a polyolester oil.

37. A direct expansion geothermal heat exchange system comprising providing refrigerant tubing design lengths at a minimum of 100 feet per ton of maximum system tonnage design when the heat exchange vapor line is within 95%, or greater, rock, where rock excludes pumice, obsidian, and all other porous rock that is not permanently water saturated;

providing refrigerant tubing design lengths at a minimum of 110 feet per ton of maximum system tonnage design when the heat exchange vapor line is within 80%, or greater, rock, or is within permanently water saturated sand, where rock excludes pumice, obsidian, and all other porous rock that is not permanently water saturated;

providing refrigerant tubing design lengths at a minimum of 125 feet per ton of maximum system tonnage design when the heat exchange vapor line is within soil; excluding soil containing 20%, or more, of clay and/or sand that is not permanently moist; and

providing refrigerant tubing design lengths at a minimum of 175 feet per ton of maximum system tonnage design when the heat exchange vapor line is within soil containing 20%, or more, of clay and/or sand that is not permanently moist.

38. A direct expansion geothermal heat exchange system comprising providing refrigerant grade tubing sizing used to connect the interior equipment, such as the compressor unit and the air handler, with the exterior sub-surface heat exchanger line sizing, as follows,

for a 12,000 BTU through 30,000 BTU compressor size, use a 3/8 inch liquid line and a 3/4 inch vapor line,

for a 36,000 BTU through 48,000 BTU compressor size, use a 1/2 inch liquid line and a 7/8 inch vapor line, and

for a 54,000 BTU through 60,000 BTU compressor size, use a 1/2 inch liquid line and a 1 inch vapor line.

39. A direct expansion geothermal heat exchange system comprising providing refrigerant tubing sizing, when utilizing a borehole method of sub-surface heat transfer tubing installation, as follows,

for a 12,000 BTU through a 30,000 BTU compressor size, use one 3/8 inch Liquid Line and one 3/4 inch Vapor Line in one borehole for all standard designs up to 125 feet per ton, with the one exception of when any one borehole exceeds 300 feet in depth, and in such event, two equally sized boreholes must be used as necessary so as not to exceed the 300 foot depth limitation per borehole, with each respective borehole utilizing one 3/8 inch Liquid Line and one 3/4 inch Vapor Line, and

for a 36,000 BTU through 60,000 BTU compressor size, use two boreholes, with each respective, and equally sized, borehole containing a respective 3/8 inch Liquid Line and a respective 3/4 inch Vapor Line, with the one exception of when any two boreholes, respectively exceed 300 feet in depth each, and in such event, three equally sized boreholes must be utilized as necessary so as not to exceed the 300 foot depth limitation per borehole, with each respective borehole utilizing one 3/8 inch Liquid Line and one 3/4 inch Vapor Line.

40. A direct expansion geothermal heat exchange system comprising providing a rope attached to the lower segment of the refrigerant transport tubing as a means to lower/extract the refrigerant transport tubing into/out of one of a borehole and a fluid filled containment pipe, together with a smooth surface rope guide placed at the surface edge of the one of the borehole and pipe.

41. The system of claim 40, further comprising providing one of a solid encasement around the lower segment of refrigerant transport tubing to be lowered into one of a borehole and a pipe, and a bar affixed to the lower segment of the refrigerant transport tubing to be lowered into one of a borehole and a pipe for at least one purpose of protection, strength, and rope attachment.

42. The system of claim 40, further comprising providing an above-ground winch, positioned at the ground surface in working proximity to a borehole, which winch is used to control the rope, secured to the lower segment of the copper refrigerant transport tubing/lines, used to lower/raise the entire sub-surface heat transfer copper refrigerant transport tubing assembly into/out of one of a borehole and a pipe.

43. A direct expansion geothermal heat exchange system comprising providing a compressor with a tonnage design capacity that is designed at 90%, plus or minus 5% of 100%, of the direct expansion system's maximum load tonnage design capacity, in the greater of the heating mode and the cooling mode.

44. The system of claim 43, further comprising providing an optional two speed compressor where one high speed is operating at full 100% BTU compressor design capacity output, and where a second low speed is operating at 67% of full compressor design capacity output, plus or minus 2% of 100%.

45. The system of claim 44, further comprising providing an optional two-speed compressor with the high speed designed for use in one of the the heating mode and the cooling mode, and with the low speed designed for use in the cooling mode.

46. A direct expansion geothermal heat exchange system comprising providing a single piston metering device in the heating mode, with the following pin restrictor (Aeroquip type) sizing, based on central hole bore size in inches, utilized, plus or minus a maximum of two (2) one thousandths of an inch (0.001) central hole bore size, within the following depth ranges,

Maximum Heating Tonnage Design............Pin Restrictor Central Bore Hole Size In Inches

*0 to 50feet (depth of borehole below compressor unit)

1.5 ....0.041

2...0.049

2.5...0.055

3...0.059

3.5..0.063

4...0.065

4.5..0.068

5...0.071

*51 to 175 feet (depth of borehole below compressor unit)

1.5 ....0.039

2...0.047

2.5..0.052

3...0.056

3.5..0.060

4...0.062

4.5..0.065

5...0.067

*176 to 300 feet (depth of borehole below compressor unit)

1.5 ....0.037

2...0.044

2.5..0.050

3...0.053

3.5..0.057

4...0.059

4.5..0.061

5..0.064.

47. A direct expansion geothermal heat exchange system comprising providing, in the cooling mode, a self-adjusting thermostatic expansion valve which is located proximate to the interior air handler and is sized at 140%, plus or minus 10% of 100%, of the maximum compressor tonnage design capacity in the cooling mode.

48. A direct expansion geothermal heat exchange system comprising providing an optional single piston metering device, situated proximate to the interior air handler in the cooling mode, with the following pin restrictor (Aeroquip type) sizing, based on central hole bore size in inches, utilized, plus or minus a maximum of two (2) one thousandths of an inch (0.001) central hole bore size, within the following depth ranges,

Maximum Cooling Tonnage Design - Pin Restrictor Bore Size In Inches

*0 to 50 feet (height of interior air handler above the compressor unit)

1.5 ....0.058

2..0.070

2.5..0.077

3..0.085

3.5..0.093

4..0.099

4.5..0.100

5...0.112.

49. A direct expansion geothermal heat exchange system comprising providing a charging of the refrigerant system in the cooling mode until the peak operational efficiency is reached and the superheat is within the 10 to 25 degree F range, the head pressure is within the 305 to 405 PSI range, the liquid head pressure is within the 195 to 275 PSI range, which is similar to the head pressure range in the heating mode, the suction pressure is within the 80 to 160 PSI range, and the suction/vapor temperature is within the 37 degree to 55 degree F. temperature range.

50. A direct expansion geothermal heat exchange system comprising providing a receiver sized to hold at least 40% of the maximum direct expansion system operational refrigerant charge.

51. A direct expansion geothermal heat exchange system comprising providing, when elements potentially corrosive to copper are encountered in the sub-surface environment, the sub-surface un-insulated vapor refrigerant transport copper tubing, as well as the sub-surface insulated liquid refrigerant transport copper tubing and its surrounding insulation, as well as all sub-surface copper couplings, are completely surrounded by a watertight protective covering prior to insertion into the borehole.

52. A direct expansion geothermal heat exchange system comprising providing, when elements potentially corrosive to copper are encountered in the sub-surface environment, the sub-surface un-insulated vapor refrigerant transport copper tubing, as well as the sub-surface insulated liquid refrigerant transport copper tubing and its surrounding insulation, as well as all sub-surface copper couplings, are all completely surrounded and encased by Grout Mix 111 after their insertion into a well/borehole and/or after their insertion into any other potentially copper corrosive subsurface environment.

53. A direct expansion geothermal heat exchange system comprising providing an optional water-tight pipe installed within a well/borehole to hold and encase the subsurface geothermal heat exchange refrigerant transport tubing, which pipe is additionally filled with a heat conductive fill material, and which pipe is surrounded by an exterior heat conductive fill material, which exterior heat conductive fill material fills the space between the exterior of the pipe's wall and the interior wall of the well/borehole.

54. The system of claim 53, further comprising providing an optional watertight pipe comprised of at least one of steel, galvanized steel, and polyethylene.

55. The system of claim 53, further comprising providing one of a fluid and a gel as a heat conductive fill material to fill the remaining interior of the optional

water-tight pipe installed within a well/borehole, which pipe primarily contains the subsurface geothermal heat exchange refrigerant transport tubing.

56. The system of claim 54, further comprising providing providing an optional fluid, comprised of at least 50% propylene glycol, as a heat conductive fill material to fill the remaining interior of the optional water-tight pipe installed within a well/borehole, which pipe primarily contains the subsurface geothermal heat exchange refrigerant transport tubing.

57. A direct expansion geothermal heat exchange system comprising providing full insulation for all of the exterior connecting refrigerant transport lines.

58. The system of claim 57, further comprising providing a protective watertight encasement for all of the exterior and insulated connecting refrigerant transport lines.

59. A direct expansion geothermal heat exchange system comprising providing no low-pressure cut-off timing switch/device for the system's compressor other than the compressor's own internal cut-off switch.

60. A direct expansion geothermal heat exchange system comprising providing an optional low refrigerant pressure cut-off timing switch/device designed to deactivate the compressor only after a minimum continuous 15 minute period of below minimum requisite system refrigerant operational pressures.

61. A direct expansion geothermal heat exchange system comprising providing returning the oil from an oil separator directly to one of the compressor's suction line prior to the accumulator and to the accumulator itself.

62. A direct expansion geothermal heat exchange system comprising providing for the addition of extra compressor lubricating oil, with the amount of extra oil to be added being determined by multiplying the system charge in pounds of refrigerant by 2.2%, and multiplying this number by 16 fl. oz. (1 pound), and by then subtracting from this result 8% of the fluid ounces of oil shown on the compressor nameplate, and by then adding the amount of oil shown, if any, to one of the system's receiver and the system's liquid line in the heating mode.